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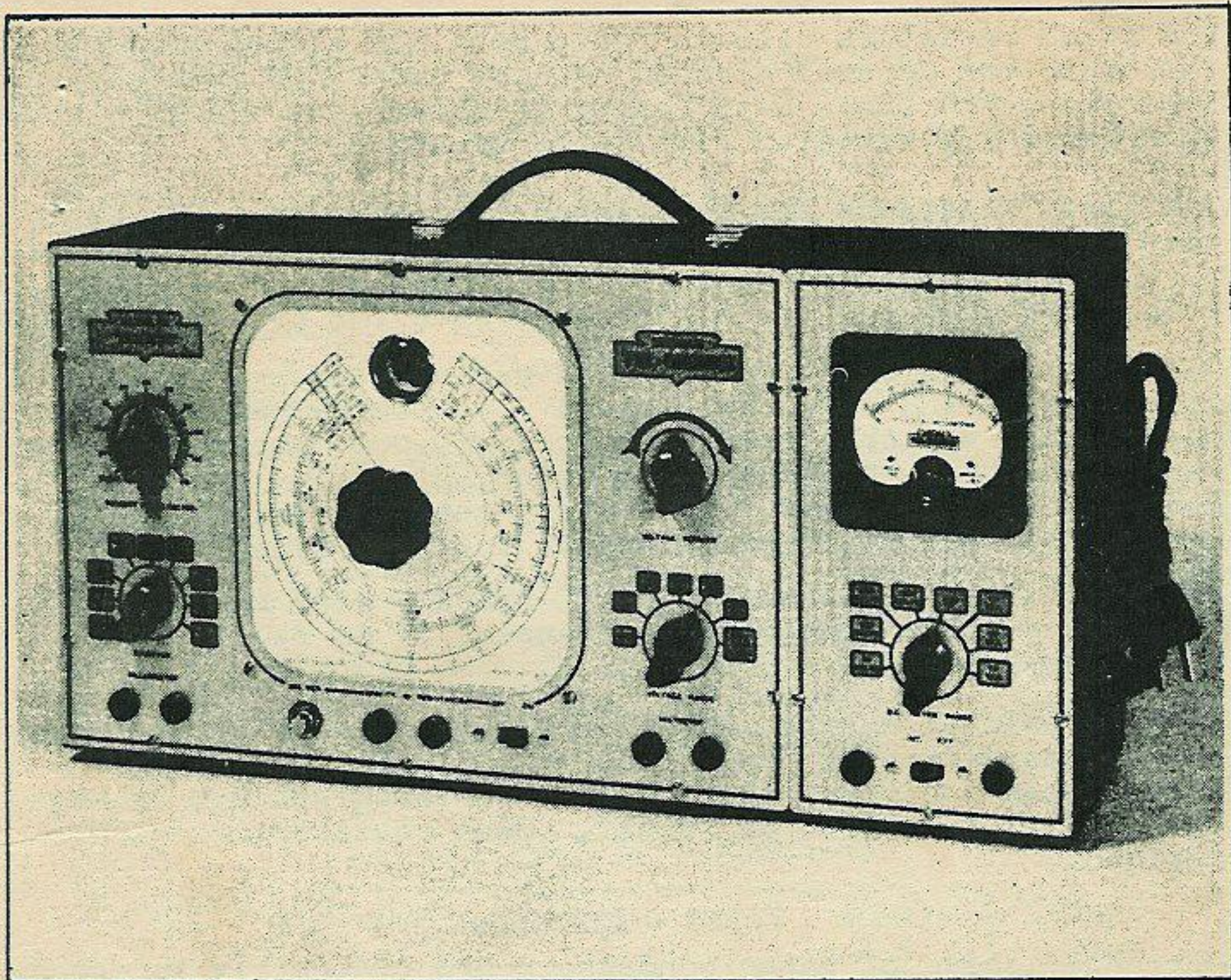
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CONDENSER & RESISTOR REPLACEMENT

CONDENSERS

The varied applications and types of condensers present a difficult problem to the service man, for he seldom has sufficient data pertaining to their normal characteristics, and he has not heretofore been able to determine the extent of changes in these characteristics which make replacement necessary. It is seldom sufficient to know only the capacity value of a condenser, because its correct performance depends as much on other factors, such as leakage current, power factor, etc., as it does on the capacity value. In order to know whether or not a condenser is satisfactory it is necessary to measure all of its characteristics.

The exact limits which are permissible on the characteristics of condensers are governed by the particular applications. Broad variations may be found between condensers of various makes, and between condensers in the same circuit positions in radio equipment made by different manufacturers. The following tables give general values for the normal characteristics of high quality condensers, and the limits from nominal rating at which a condenser would ordinarily be considered unsatisfactory and in need of replacement.

THE SPRAGUE DELUXE TEL-OHMIKE makes it possible to measure all of the important characteristics of condensers, under their working conditions, and by consulting the tables to know when they are faulty and in need of replacement.

RESISTORS

The fixed resistors used in radio sets and allied products fall into two general classes - the carbon or composition type generally three watt rating or under, and the wire wound type generally rated at five watts or above.

The usual tolerance for the carbon type is $-20\% +20\%$, while that for the wire wound type is usually $-10\% +10\%$. The manufacturer's service notes generally indicate the resistors which should be held to closer tolerance for proper operation.

Volume controls or other variable resistances may also be divided into the same two classes - carbon and wire wound. In general, variable resistors above 50,000 ohms are of the carbon type, however those below this value are not necessarily wire wound. The tolerances are usually the same as for the fixed resistors of the same type.

If a resistor, as measured on TEL-OHMIKE, does not fall within the above mentioned tolerances, it is faulty and should be replaced.

If the resistor has faulty internal contacts or connections or is intermittently "open" the eye will not remain at a steady open position, as explained in Paragraph 5-D on Page 8, but will "flicker" or "wink". Such resistors should be replaced.

PAPER CONDENSERS

Characteristics of paper condensers are ordinarily independent of voltage rating.

CAPACITY TOLERANCE	Up to .002 MFD		Over .002 MFD	
	NORMAL	REPLACE	NORMAL	REPLACE
Filter and By-Pass Condensers	- 25% + 50%	- 33% + 100%	- 10% + 40%	- 20% + 100%
Coupling Condensers	- 20% + 20%	- 30% + 30%	- 20% + 20%	- 30% + 30%

LEAKAGE RESISTANCE	NORMAL	REPLACE
Filter and By-Pass Condensers	500 Megohms per MFD above .1 MFD. 5,000 Megohms total resistance per condenser for condensers less than .1 MFD.	100 Megohms per MFD. above .1 MFD. 1,000 Megohms total resistance per con- denser for units less than .1 MFD.

Divide total leakage resistance in Megohms by capacity in MFD. If the value is less than 100 Megohms/MFD the condenser should be replaced.

Coupling Condensers	500 Megohms per MFD above .1 MFD. 5,000 Megohms total resistance per condenser for condensers less than .1 MFD.	When leakage re- sistance falls to 20 times the value of the grid resistance.
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Where a condenser is used in series with a resistor, such as in AVC circuits, the leakage resistance of the condenser should be at least 50 times the value of the resistor in Ohms.

OIL CONDENSERS

Characteristics of oil condensers are ordinarily independent of voltage rating.

CAPACITY TOLERANCE	NORMAL	REPLACE
Filter and By-Pass Condensers	- 5% +10%	- 10% +100%
Coupling Condensers	- 5% +10%	- 10% + 20%

LEAKAGE RESISTANCE:

Exact value required depends on application. Minimum value should never be less than 100 Megohms per microfarad of capacity. (See notes under Paper Condensers).

DRY ELECTROLYTIC CONDENSERS

CAPACITY TOLERANCE	NORMAL	REPLACE
	- 10% + 60%	- 20% +120%
POWER FACTOR	NORMAL	REPLACE
Filter Condensers	15%	25%
By-Pass Condensers	25%	40%

LEAKAGE CURRENT:

All measurements should be made at room temperature (75°F.). Leakage current should be read after rated working voltage has been maintained on the condenser for a five minute period. The time required for the leakage current to fall to normal value is as important as the value of the leakage current itself. Condensers which require more than five minutes to fall to normal leakage should be replaced.

	NORMAL	REPLACE
Filter Condensers	.5 M.A. + .05 M.A./MFD.	1 M.A. + .06 M.A./MFD.
By-Pass Condensers	.1 M.A. + .01 M.A./MFD.	.2 M.A. + .015 M.A./MFD.

The permissible value of leakage current is dependent on the value of capacity, and is given in the table as a constant value of current plus a value dependent on the capacity. Permissible leakage current is figured as follows: for an 8 MFD filter condenser: $.5 \text{ M.A.} + (8 \times .05) \text{ M.A.} = .5 + .4 = 0.9 \text{ M.A.}$

Some of the older types of condensers, when operated in radio equipment at voltages lower than their rating, undergo changes which tend to deform them into condensers of the lower voltage rating. This effect is usually accompanied by an increase in capacity of the condenser. When condensers of this type are removed from the low voltage and are measured at their original rated voltage they will have a very high leakage current which will not fall to normal, and will sometimes fail in a few minutes, due to their inability to reform themselves to their original voltage rating.

If such condensers have the normal leakage currents, shown above, at the voltage at which they actually operate, they will usually be satisfactory, providing the other characteristics are correct, and need not be replaced.

Modern condensers which are correctly designed and manufactured will not show this "deforming" effect, but will only require sufficient time for the leakage to fall to normal.

MOTOR STARTING CONDENSERS

CAPACITY TOLERANCE	NORMAL - 5% +10%	REPLACE - 10% + 25%
POWER FACTOR	NORMAL 10%	REPLACE 15%

WET ELECTROLYTIC CONDENSERS

There are two types of wet electrolytic condensers in use in radio receivers; the "standard" wet and the "regulating" wet condensers. The "standard" type is the conventional wet condenser, while the "regulating" type is a special condenser designed to regulate the voltage out-put from the rectifier system while the tubes in the set warm up.

Regulating wet condensers are sometimes marked with an "R", but many are in service without this marking. Practically all 300 and 350 rated working voltage wets in service are of the regulating type. Wet condensers of these voltage ratings should be replaced with regulating wets, such as Sprague catalogue numbers WC-83 and WC-40.

Before replacing a regulating wet condenser the DC voltage across it should be measured, after the receiver has thoroughly warmed up, to be certain that the voltage rating

of the condenser is not exceeded. Practically all failures of regulating wets are caused by excessive DC voltage under high line voltage conditions. If the DC voltage exceeds the rating of the "regulating" condenser it is best to replace it with a standard high voltage wet condenser, and to replace the other filter and by-pass condenser in the set with units of proper voltage rating.

In some radio receivers wet condensers of 300 and 350 volts rating will be found connected in series with a high resistance of the order of 10,000 to 30,000 Ohms. These are not "regulating" wets, and should be replaced with "standard" wets of proper voltage rating.

CAPACITY TOLERANCE	NORMAL	REPLACE
	-10% +50%	-20% +100%

These tolerances apply to both "standard" and "regulating" types of wet condensers.

LEAKAGE CURRENT	NORMAL	REPLACE
	1 M.A. + .1 M.A. per MFD. Maximum value 2.5 M.A.	Leakage current over 2.5 M.A.

The time required for the leakage current to fall to the normal value is as important as the value of the current itself. When the rated working voltage is applied to a wet condenser the leakage current should fall to the normal value in a period not exceeding 5 minutes for the standard wets and 10 minutes for the regulating type of wet condenser. Condensers which draw more than the above values of current at the end of the times given should be replaced. (See the data under Dry Condensers for old type condenser on which the leakage current will not fall to normal. Any wet condenser which makes a "hissing" or "sparkling" sound at any voltage up to rated voltage plus 10 volts is defective and should be replaced.

POWER FACTOR:

The permissible power factor of wet electrolytic condensers varies with the rated capacity and working voltage. The following table gives the normal and replacement values for "standard" wet electrolytic condensers. The permissible values for "regulating" wets are twice the values given in the table.

POWER FACTOR OF WET ELECTROLYTIC CONDENSERS IN % AT 60 CYCLES

RATED D.C. WORKING VOLTAGE											
MEASURED CAPACITY IN MICROFARADS	0 to 350 VOLTS				450 to 475 VOLTS		500 VOLTS		525 VOLTS		
	NORMAL	REPLACE	NORMAL	REPLACE	NORMAL	REPLACE	NORMAL	REPLACE	NORMAL	REPLACE	
4	9%	25%	10%	25%	12%	25%	13%	25%	13.5%	25%	
6	11	25	13.5	25	17	26	18	27	19	29	
8	12	25	15	25	20	30	22	33	23	35	
10	15	25	18.5	28	24	36	26	39	27	41	
12	18	27	22	33	28	42	30	45	32	48	
14	18.5	27.5	22	33	28	42	30	45	32.5	49	
16	20	30	24	36	29	43	32	48	34	51	
18	20	30	24	36	32	48	35	53	38	57	
20	22	33	26	39	32	48	36	54	38.5	58	
25	23	34.5	28	42	34	51	36	54	39	59	
30	27	40	32	48	37	51	41	61	45	68	
35	27	40	33	49	37	56	42	63			
40	29	43.5	35	53	37	56	42	63			

DELUXE TEL-OHMIKE OPERATING INSTRUCTIONS

TO USE THE TEL-OHMIKE VOLTMETER AND MILLIAMMETER EXTERNALLY, PLACE THE SLIDE SWITCH BELOW THE METER IN THE EXT. POSITION, INSERT TEST LEADS IN THE TIP JACKS ADJACENT TO THE SWITCH, AND PLACE THE METER RANGE SWITCH IN THE DESIRED POSITION.

1. ELECTROLYTIC CONDENSER LEAKAGE:

- A. Insert the line plug in a 115 V. 60 cycle receptacle and turn the OFF-ON switch ON.
- B. Set the SELECTOR to the ELEC. LEAK. position, the Slide Switch above the POWER FACTOR control to the ELEC. position, and the VOLTAGE RANGE control to the OFF position.
- C. Set the DC METER RANGE switch to a Voltmeter range near that of the Voltage rating of the Condenser being tested. (For a 450 V. condenser use the 500 V. meter range). Place the slide switch (under the METER RANGE switch) in the INT. position.
- D. Insert the condenser to be tested in the "Capacity or Resistance" tip jacks observing polarity. (Red is POSITIVE).
- E. Adjust the Polarizing Voltage by means of the VOLTAGE RANGE & VERNIER controls until the Voltmeter reading equals the voltage rating of the condenser.
- F. Turn the METER RANGE switch to the Milliammeter position and read the leakage current on the meter.

2. ELECTROLYTIC CONDENSER CAPACITY AND POWER FACTOR:

IMPORTANT: In order to prevent damage to your Tel-Ohmike ALWAYS check electrolytic condensers for leakage as noted above BEFORE measuring the Capacity. See the tables on Pages 3 & 5 for permissible values of leakage current. Condensers with leakage current greater than normal should be replaced and should NOT be checked for capacity. Condensers which show no measurable leakage current at normal polarizing voltage are open and should be replaced.

- A. Turn the METER RANGE Switch to the OFF position. Always have this switch in the OFF position except when measuring current or voltage.
- B. Turn the SELECTOR to the C₃ or C₄ position depending upon the capacity to be measured (C₃ for condensers up to 50 MFD; C₄ for condensers up to 2,000 MFD).
- C. Rotate the center control until maximum opening of the "eye" is noted. Adjust the POWER FACTOR control for maximum "eye" opening, and readjust the center control if necessary. Read the Capacity and Power Factor directly. If a balance is obtained at either the low or high end of the scale, best accuracy will be obtained if the next lower or higher range is used thereby bringing the balance point nearer the center of the scale. The chart at the right gives intermediate values of capacity on the C₄ scale in terms of readings on the C₃ scale. Thus condensers giving a balance at the high end of the C₃ scale can be more accurately measured on the C₄ range. If the "eye" winks rapidly or flutters after a balance is obtained, there is an "intermittent open" either in the condenser being tested or in the connections.

CAPACITY	C ₃ READ.
42 MFD	.1
44	.2
46	.3
48	.4
52	.6
54	.7
56	.8
58	.9

3. PAPER, MICA & OIL CONDENSER INSULATION RESISTANCE:

- A. Insert the condenser to be tested in the "Capacity or Resistance" tip jacks.
- B. Set the SELECTOR to the INS. RES. position.
- C. Set the METER RANGE SWITCH to either the 500 or 1,500 Volt position as outlined in Section D.
- D. Set the Voltage to 400 Volts for condensers with a DC rating below 400 Volts and to 1,000 Volts for condensers rated above 400 Volts. (The output at the 1,000 Volt tap cannot be varied).
- E. Set the center control at the low end of the Insulation Resistance scale when starting the measurement. Depress and release the INS. RES. push-button while advancing the indicator slowly until the "eye" does not change as the button is depressed. The insulation resistance is indicated in Megohms on the INS. RES. scale. (See table under Paper Condensers). Sufficient time must be allowed for the condenser to charge fully since the true insulation resistance can be measured only when the condenser is fully charged. When voltage is first applied to a condenser a charging current flows which will cause a false reading. High capacity condensers take an appreciable time to charge, sometimes as long as three minutes. If the "eye" opens as the button is depressed, at all points on the scale, (after allowing the condenser sufficient time to charge) the insulation resistance is below 250 Megs. and the condenser should be replaced.

4. PAPER, MICA & OIL CONDENSER CAPACITY AND POWER FACTOR:

- A. Place the slide switch in the PAPER-MICA position and set the Power Factor control at 0.
- B. If the Condenser to be measured is below .001 MFD insert the leads directly in the "Capacity or Resistance" tip jacks without using test leads. The use of long test leads, which have some capacity, may give incorrect capacity readings when very low capacities are measured.
- C. Place the SELECTOR in the C_1 , C_2 , C_3 position depending upon the capacity to be measured. No polarizing voltage is needed for this test.
- D. Rotate the center control for maximum "eye" opening and read the capacity directly from the scale used. If the C_3 range is being used Power Factor can also be measured. In this case adjust the Power Factor control for maximum opening of the "eye" as in Section 2-C. While the permissible power factor depends upon the application, in general if the balance is obtained above 5%, the condenser should be replaced.
- E. If the balance for a large condenser is obtained at a low capacity part of the scale the condenser is open. If the balance is obtained at the high capacity part of the scale, a short is indicated. For example if the condenser is marked .1 MFD and the Tel-Ohmike shows a reading of less than .001 on the C_2 scale the condenser is open, while a reading of over .5 MFD on the C_2 scale would indicate that the condenser was shorted.

5. RESISTANCE MEASUREMENT

- A. Set the SELECTOR to the R_1 , R_2 , or R_3 position depending upon the value of the resistance being measured.
- B. The POLARIZING VOLTAGE control should be OFF.
- C. Insert the resistor to be measured in the "Capacity or Resistance" tip jacks.
- D. Rotate the calibrated control to the point which gives maximum eye opening. Read the resistance in Ohms or Megohms directly.

GUARANTEE

The SPRAGUE TEL-OHMIKE is fully guaranteed against defects in materials and workmanship for a period of one (1) year from the date of receipt by the owner. Our guarantee is limited to the repair or replacement, at our expense, of defective material or workmanship, provided the instrument is returned to us in accordance with the instructions noted below. This guarantee is void if the seal on the rear of the instrument has been removed or tampered with. THIS GUARANTEE IS NOT VALID UNLESS THE ATTACHED REGISTRATION CARD IS PROPERLY FILLED IN AND RETURNED TO SPRAGUE PRODUCTS COMPANY.

NOTE: If the return of this instrument is deemed necessary, advise SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASS., by mail, of the reason, BEFORE SHIPMENT. Our reply and instructions will reach you within three (3) days after receipt of your letter. No adjustments will be made unless our consent for the return of the instrument is FIRST obtained.

In making shipment for return, pack carefully, mark FRAGILE, and SHIP ONLY by EXPRESS, PREPAID.

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